

COMPARING TRADITIONAL MATH INSTRUCTION TO ONLINE INSTRUCTION:
PREPARING STUDENTS FOR THE KANSAS COLLEGE AND CAREER READY
STANDARDS

By

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ABSTRACT

Students in the United States continue to score lower on math assessments compared to students in other industrialized nations with the United States outspending every country on education. Current instructional practices and an emphasis on state assessments have not helped prepare students. Differentiated instruction may be necessary to help learners achieve greater gains in math. This study focused on two fifth grade classrooms. Students in the control class received traditional math instruction including worksheets, while students in the experimental class used www.Mangahigh.com, a program utilizing computer adaptive technology, rather than worksheets. While there was no difference in pre- and posttest scores for the first math unit, there was a statistically significant difference in students' test scores for the second unit. A survey of students' self-perceptions toward and enjoyment of math found positive gains for students in the experimental class but not in the control class. Implications for teachers are discussed.

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CHAPTER 1

INTRODUCTION

Introduction to Problem

The 2011 Trends of Mathematical and Science Study (Provasnik, Kastberg, Ferraro, Lemanski, Roey, & Jenkins, 2012) reported that fourth grade students in the United States placed 11th out of fifty countries while financially outspending every other nation on education. This has led teachers, administrators, elected officials, parents, and concerned citizens to ask the same question: what are we doing wrong?

Some argue that we need to look more closely at how we are educating our students. For example, Tomlinson (2001) states that “in many classrooms, the approach to teaching and learning is more unitary than differentiated. For example, fifth graders may all listen to the same explanation about fractions and complete the same homework assignment” (p. 1). This model of teaching the same information to all students in the same manner has been present in classrooms for generations. That is, while teachers and students have switched from quill and ink, to chalk, to pencil, to dry erase marker, the practice has remained largely unchanged in most learning communities. This unitary method of teaching was further stressed through the Elementary and Secondary Education Act (ESEA) known as No Child Left Behind (NCLB). The goal was to ensure that “no child was left behind” by teaching and testing basic skills. However, for many struggling students, this type of instruction did not close the gaps necessary to meet the standard, while higher-level students were often prevented from reaching their full potential as teachers were pressed to teach to the test instead of individualizing instruction to meet the needs of their students. Thus, the question remains: how to meet the needs of all students?

Current Practices

Far too often, intermediate grade math classes fall into that familiar trap of teaching in a unitary manner. Specifically, math teachers tend to use “traditional instruction—which is still overwhelming predominate in American schools—the major theme is for teachers to demonstrate, and students to practice formal symbolic procedures” (Battista, 2001, p. 43). In short, the instructor begins the lesson at the front of the classroom lecturing to students who are taking notes. Although, in recent years the practice of lecturing has been transformed by using technology, many teachers are confusing the use of an iWrite or SMARTboard as utilizing technology to better interact with their whole class. It is, however, just another form of whole class lecturing. After the teacher completes the lecture and the students the note taking, the teacher leads the class through a series of problems at the same pace. While this practice has its place, it can often be too slow for students who understand the concept or too frustrating for students who need one-on-one or small group support to understand the concept, so students become bored and unmotivated, which can then lead to classroom management issues. Next, students are expected to engage in independent practice related to the math concept. This task, far too often a worksheet, which may have dozens of problems on it, but the problems may begin too easy or too hard—depending on the student’s ability level.

However, teachers can use a different instructional approach. Take for example a 3rd grade teacher who is requiring her students to learn their multiplication facts. Each day, she gives the students time to practice with flash cards and play other math fact games. Then, each student is given a times table test and must pass an assessment over their “ones” before moving on to their “twos” and so on. She understands that it does not make sense to wait until *every*

student understands their “ones” before allowing the entire class to progress to the next level. She gives each student the flexibility to move at their own pace.

This same pedagogy however, does not occur often enough during dependent and guided practice. Teachers administer the same worksheet for their entire class and expect each student to do the same problems—regardless of their understanding or ability level. While the teacher understands each student must learn their “ones” before their “twos”, that same teacher needs to utilize this practice during independent practice.

An old Chinese Proverb states, “Tell me, I forget. Show me, I remember. Involve me, I understand!” NCLB ushered in a new era and a new focus on instruction, unfortunately though, with unintended consequences because instruction became hyper-focused on assessments. As Tate (2010) states, there was an “increased emphasis on high-stakes testing [and] teachers [were] apt to spending the majority of their time using worksheets and lecture to teach lower-level concepts that can be best assessed by paper and pencil” (p. 5), which shifted the focus of instruction from understanding content to assessment. “Teaching to the test” became an all too familiar phrase used in school district board offices and teacher’s lounges and the practice became so commonplace that some teachers were given instructions on how to formulate the phrase in politically correct context. For example, as Popham (2005) urged “I implore you to never use this ambiguous expression yourself. Rather say either ‘teaching to the test’s items’ or ‘teaching to the content represented by the test’” (p. 312).

While NCLB and all of its assessments have had critics, one of the advantages of NCLB and computer-based assessments is the data collected; however, the data collected is not impacting instruction because it is often underutilized. While students are not only taking more state assessments, they are also taking more preliminary tests to prepare for these assessments.

Yet, according to multiple studies by The United States Department of Education, far too often teachers were not making data informed decisions in their classrooms. That is, “data from student data systems are being used in school improvement efforts but are having little effect on teachers’ daily instructional decisions as evidenced in case study districts” (Means, Padilla, DeBarger, & Bakia, 2009, p. 10). However, Means, Chen, and Padilla (2011) found that when teachers are presented a table with data on fictional students that showed how students scored on each individual objective, “teachers are more likely to think about differentiating instruction when provided with individual student-level data broken down by concept” (p. 55). In short, worksheets and previous methods of data collecting do not give teachers the necessary data to appropriately differentiate their instruction. Instead, “in order for student data and data systems to have a positive influence on student learning, teachers not only need to locate, analyze, and interpret data, but also to plan and provide differentiated instruction through techniques such as individualized learning plans” (Means, et.al., 2011, p.). This is a high expectation given that current practices do not provide an environment for this to occur.

Because teachers do not have the data to individualize instruction, traditional math instruction, which places an emphasis on computation rather than on problem solving, will continue. Students will spend the majority of their time completing problems that could be computed on a calculator (Battista, 2001) and will be taught a specific skill and asked to repeat it over and over again until it “sticks.” In short, students will have memorized the process, but may have no understanding of the concept. For example, Battista (2001) uses the problem “What is $2\frac{1}{2} \div \frac{1}{4}$?” “Traditionally taught students are trained to solve such problems by using the ‘invert and multiply’ method (which students memorize, quickly forget, and almost never understand)” (Battista, 2001, p. 44). The teacher explains that in order to solve this problem, a student must

change “ $1/4$ ” into “ $4/1$ ” and now to multiply $2\frac{1}{2} \times 4$, but “the focus on computation skill is so narrow that those students who are lucky enough to be able to compute the answer rarely can explain or demonstrate why the answer is correct (other than saying something like, ‘My teacher said we are supposed to invert and multiply’)” (Battista, 2001, p. 44).

However, there is another way of teaching students math in general and fractions in particular. For example, during the “Teach Me” process of dividing fractions on Mangahigh, a math website which employs computer adaptive technology, students are provided with another look at this difficult to understand concept. The screenshots below show the scaffolding. First a student reviews how to multiply fractions and then the student is shown a problem with two number lines. The first number line identifies $3/5$ on a 0-1 number line. The second number line shows an identical number line (0-1), but now the line is half as long. The problem reads “so $3/5 \div 2 =$.” This simple illustration takes dividing fractions from memorizing “invert and multiply” and puts it into a step-by-step process the student can follow. The student completes two more problems using a singular number line. Next, the student is given a screen that explains what he has done and explains to the student how he *could* use a number line each time to count the number of “spaces,” but that the process of invert and multiply simplifies this step. Lastly, the students complete a problem using the invert and multiply method, but now with a clearer understanding of why this method actually works.

FOR FULLSCREEN Page 1 of 6 LEARN MODE

Try this first

Drag in the right numbers to complete the working.

$$\frac{2}{3} \times \frac{4}{5} = \boxed{}$$

12
6
15
10
8


SUBMIT ANSWER

SHOW HINT SHOW SOLUTION

Figure 1: Teach Me – Step 1

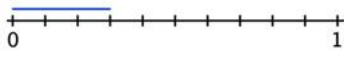
FOR FULLSCREEN Page 2 of 6 LEARN MODE

The blue line on this number line shows $\frac{3}{5}$



0 $\frac{3}{5}$ 1

This diagram shows the blue line divided by 2



0 1

So $\frac{3}{5} \div 2 = \boxed{}$

6/5
1/5
3/10

SUBMIT ANSWER

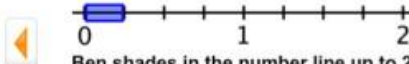
SHOW HINT SHOW SOLUTION

Figure 2: Teach Me – Step 2

mangahigh.com is now full screen. [Exit full screen \(Esc\)](#)

FOR FULLSCREEN Page 3 of 6 LEARN MODE

The blue rectangle on the number line shows $\frac{1}{4}$



Ben shades in the number line up to 2 using quarters.

He needs rectangles.

So $2 \div \frac{1}{4} =$

[SHOW HINT](#) [SHOW SOLUTION](#)

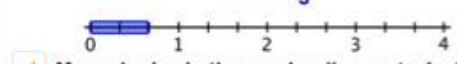
4
2
16
2
8
8
4
16

SUBMIT ANSWER

Figure 3: Teach Me – Step 3

FOR FULLSCREEN Page 4 of 6 LEARN MODE

The blue rectangle on this number line shows $\frac{2}{3}$



Myra shades in the number line up to 4 with rectangles of length $\frac{2}{3}$

She needs rectangles.

So $4 \div \frac{2}{3} =$

[SHOW HINT](#) [SHOW SOLUTION](#)

6
3
3
4
8
6
4
8

SUBMIT ANSWER

Figure 4: Teach Me – Step 4

mangahigh.com is now full screen. [Exit full screen \(Esc\)](#)

FOR FULLSCREEN Page 5 of 6 LEARN MODE

To divide by a fraction you need to **turn the fraction upside down** (invert it) then **multiply**

$\frac{3}{5} \div 2 = \frac{3}{10}$ is the same as $\frac{3}{5} \times \frac{1}{2} = \frac{3}{10}$

$4 \div \frac{2}{3} = 6$ is the same as $4 \times \frac{3}{2} = \frac{12}{2} = 6$

This works even if both numbers are fractions:

$\frac{4}{5} \div \frac{7}{3} = \frac{12}{35}$ is the same as $\frac{4}{5} \times \frac{3}{7} = \frac{12}{35}$

Figure 5: Teach Me – Step 5

mangahigh.com is now full screen. [Exit full screen \(Esc\)](#)

FOR FULLSCREEN Page 6 of 6 LEARN MODE

Complete the working.

$\frac{3}{4} \div \frac{2}{5}$ is the same as

$\frac{3}{4} \times \frac{\quad}{\quad} = \frac{\quad}{\quad}$

6
5
20
8
15
2

SUBMIT ANSWER

SHOW HINT SHOW SOLUTION

Figure 6: Teach Me – Step 6

Further, Mangahigh gives the teacher real-time data on each student. The teacher can log on to the website and see what skills her students have been working on. And as noted earlier in

this introduction, a teacher is more likely to make data-driven decision when provided with a table full of relative data (Means, 2001). She can view how many problems a student has attempted, the percent of problems they have done correctly, and how many attempts it took them to complete the challenge (See Appendix A).

New Challenges of Common Core

During the 2014-2015 school year, 45 states along with four territories and the District of Columbia will begin teaching to new standards known as the Common Core State Standards (CCSS) which “provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them” (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The CCSS states that these standards aim to better prepare students for career or college and with new standards, comes a new assessment. Two organizations have been commissioned to develop a new assessment to measure students’ progress toward achieving these new standards: Smarter Balanced Assessment Consortium (SBAC) and ePartnership for Assessment Readiness for College and Careers (PARCC-).

CCSS has outlined eight mathematical practices to explain the proficiency necessary to teach students of all levels. The practices frame the “processes and proficiencies” that are the cornerstone of mathematics instruction (NGA & CCSSO, 2010). They used the process standards set by the National Council of Teachers of Mathematics (NCTM): problem solving, reasoning and proof, communication, representation, and connections as well as the National Research Council’s Report, *Adding it up*, which will be addressed later in this literature review (NGA & CCSSO, 2010).

According to their website, www.smarterbalanced.org, “the Smarter Balanced Assessment Consortium is creating next-generation assessments aligned to the Common Core State Standards (CCSS) in English language arts/literacy and mathematics. Just as the CCSS describe the knowledge and skills students need to be prepared for college and career, the system of computer adaptive assessments—including summative and formative tests—will provide important information about whether students are on track, as well as resources and tools for teachers to help students succeed” (smarterbalanced.org, 2013). This method of assessing student learning will require teachers to not only modify how they teach, but also how they collect and use data from pre- and formative assessments.

Mangahigh: A Math Website

The website, www.Mangahigh.com, based in Great Britain, has created online math tasks called “prodigis” that focus on a specific skill in mathematics. Teachers from around the world can use Mangahigh because it allows educators to choose curricula from Great Britain, Canada, Australia, Brazil, as well as many other countries, including the United States and the CCSS. After creating an account for themselves, teachers create individual accounts for their students. A teacher selecting the CCSS curriculum can choose from over 700 lessons for students ranging 2nd grade through high school. From simple addition and basic shapes, to interpreting categorical and quantitative data and arithmetic with polynomials and rational expressions. In short, elementary, middle, and secondary teachers have many prodigis to utilize when using Mangahigh.

Mangahigh, unlike other online resources, such as www.KhanAcademy.org and www.LearnZillion.com, helps students practice specific math skills at the most appropriate

difficulty level. While Mangahigh does not set out to teach the lesson, it does offer a “Teach Me” feature for each skill which students can make use of before their first attempt of a prodigi or use as for review when needed. The “Teach Me” feature walks the students through a handful of problems reminding them of the mathematical processes for that skill. Mangahigh claims the effectiveness of their website comes from its “adaptivity, automaticity, discipline and self-learning, and application of theory” (www.Mangahigh.com, 2013). The website is a tool to engage learners in higher level thinking and to find their zone of proximal development. The purpose of Mangahigh is not to replace the teacher; it is to set the teacher free after giving initial instruction so that students can learn at their own pace. The teacher will need to circle the room, answer questions, and reteach students who do not understand the concept, but allows students who understand the concept are able to learn at their own pace.

Summary

Based on international comparison, student in the U.S. are doing poorly in math. This may be due, in part, to the fact that teachers tend to provide math instruction in a traditional manner. That is, the use of lectures and worksheets, which often do not meet the needs of diverse learners. However, by using internet-based programs, teachers might be better able to meet the diverse needs of their students. That is, some Internet programs, such as www.Mangahigh.com, adapt the types of math problems students are presented based on their previous responses. Despite their potential, it is unclear if students would benefit from such programs and how such programs might influence their attitude toward math. Thus, the aim of the proposed study is to determine the effectiveness of the website www.Mangahigh.com when compared to traditional forms of independent practice in a fifth grade classroom. The second aim of this study is to

explore students' attitude towards math, specifically their enjoyment and self-perceptions, and if there is any difference between students who use Mangahigh compared to students in a traditional math class.

CHAPTER 2

LITERATURE REVIEW

Introduction

In this literature review, I briefly discuss the traditional format for teaching students—lecture, guided practice, independent practice—and show that it still has merits; however, teachers also need to place a greater emphasis on differentiated instruction. Next, I present information on www.Mangahigh.com and how it allows teachers to create more flexibility in their teaching compared to traditional teaching methods by allowing teachers to better differentiate their instruction to meet students' individual needs. Thirdly, I explore the importance of technology in the classroom in regards to student “buy-in” with millennials (also known as Generation Y). Lastly, I discuss the changes in how students are assessed and how computer adaptive assessments will differ from the previous style and design of assessments.

Differentiated and Individualized Instruction

Differentiated instruction is student centered learning, but it is not individualized instruction (Tomlinson, 2001). Individualized instruction creates an environment where students not only learn at their own pace, but also choose the skills they want to master. In the 1970's teachers experimented with the idea of creating an individualized lesson to meet each students personal learning style (Tomlinson, 2001). While this idea had merit, it was ultimately discontinued, because it was nearly impossible for a teacher to individualize lesson after lesson for each student. While Mangahigh does not promise to individualize each lesson, it can differentiate instruction based on its large database of questions that allow it to zero in on the

appropriate level of questions and activities after analyzing students' responses to questions. As Tomlinson (2001) states, "because the primary intent of differentiated instruction is to maximize student capacity, when you see (or have a hunch) that a student can learn more deeply, move at a brisker pace...that's a good time to offer advanced learning opportunities" (p. 11). Using computer adaptive technology, Mangahigh identifies appropriate instructional activities for students and, at the same time, it prevents students from proceeding too quickly if they are struggling with lower-level questions, while challenging students who are prepared for higher-level questions. Further, when teachers use Mangahigh, they are in a better position to find the appropriate zone of proximity for their students.

Using Mangahigh, students move from "easy" to "medium" to "hard" to "challenging" questions. Further, teachers can differentiate each lesson on Mangahigh by deciding whether their students need to earn a bronze (4,200 points), silver (9,000 points), or gold (14,000 points which is ten straight questions correct at the "challenging" level). That is, students are expected to answer ten questions each round and they can earn more points by answering questions correctly. In addition, high level questions earn more points and students are allotted more time to answer them.

If a student answers three questions in a row correctly, he moves up one level in difficulty (e.g. from easy to medium questions); if the student answers two questions in a row incorrectly he moves down one level. Students can also earn more points in the following round by reviewing their incorrect answers and reading a short tutorial on each incorrect response to understand the mistakes they made. In short, Mangahigh differentiates instruction based on each student's responses and provides problems that are within their zone of proximal development.

Student “Buy-In”

Student “buy-in” is a key to any lesson plan and it is important to keep an eye on students’ frustration levels, especially struggling learners. That is, “few adults elect to spend the majority of their day practicing what they can’t do...Struggling learners are more likely to retain motivation to learn when their days allow them to concentrate on tasks that are relevant and make them feel powerful” (Tomlinson, 2001, p.13.). In addition to students’ intrinsic motivation to learn concepts and do well in math, the Mangahigh medal system provides students with extrinsic motivation because they can tangibly see that they mastered the concept at a specific level (i.e., bronze, silver, or gold). Earning medals also provides extrinsic motivators for a student such as selecting a new avatar for her account or challenging another school to a friendly competition know as a “Fai-to” where two schools attempt to earn as many medals as they can during a five to nine day match.

While, Lepper, Corpus, and Iyenarg (2005) found that “there was a positive relationship between intrinsic motivation and performance both in class and on standardized tests” (p. 192), they also found that intrinsic motivation drops as students get older. Perhaps this is because as students move through the grades and material becomes more difficult, and as they encounter primarily lecturing and worksheet practice, they are unable to progress at their own pace and therefore become disinterested (if held back) or frustrated (if unable to keep up). Thus, Mangahigh has the potential to help students maintain their intrinsic motivation by providing extrinsic motivation.

Different instructional methods are also needed when teaching students with special needs. Kilpatrick (2003) discusses in *Adding it Up*, three common mistakes that a teacher makes

when teaching students with special needs: (1) not assessing, fostering, or building on students' informal knowledge; (2) overly abstract instruction that proceeds too quickly for students; and (3) instruction that relies on rote memorization of mathematics. As previously stated, Mangahigh allows a teacher to build on a students' knowledge and prevents students from moving too quickly by continually assessing them at their level of proximal development. It also avoids instruction that is purely memorizing mathematics on rote by giving students a variety of questions that require critical thinking on each topic. Thus, Mangahigh has the potential to support students with special needs.

Further, Mangahigh has the potential to help student achievement with the new CCSS. For example, CCSS standard 5.NF.A.1 reads, "Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators." Mangahigh, just as the standard is written, is designed to slowly build on a skill. When each student begins their first prodigi they will see an "easy" level question such as the one below.

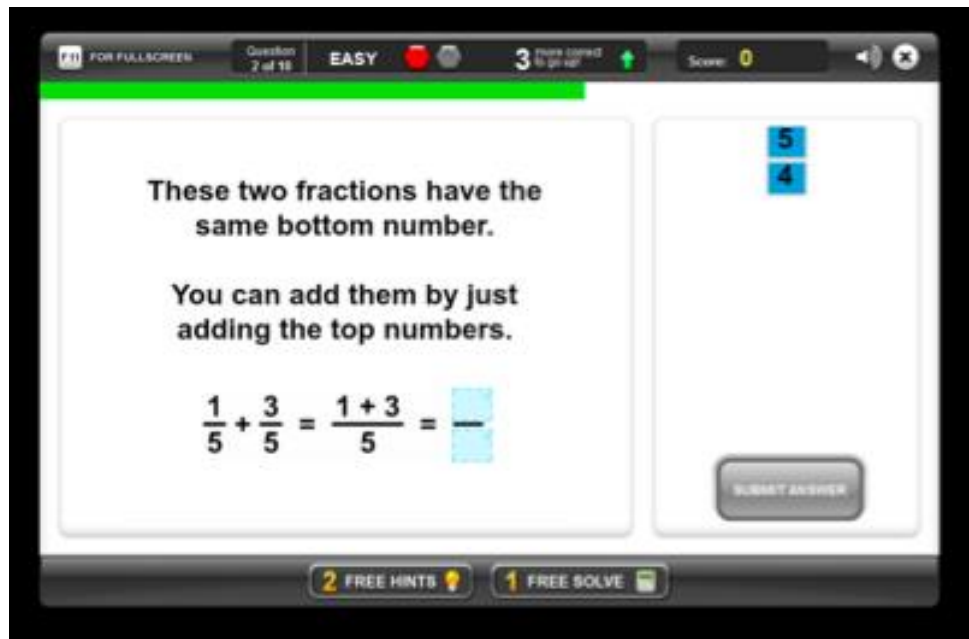


Figure 7: Mangahigh “Easy” question

This “easy” level question lines up the problem for the student by showing him that fractions can be added because they have the same “bottom number.” It scaffolds easy level questions by simplifying the vocabulary from “denominator” to “bottom number.” After correctly answering three “easy” level question, a student would move onto “medium” level questions.

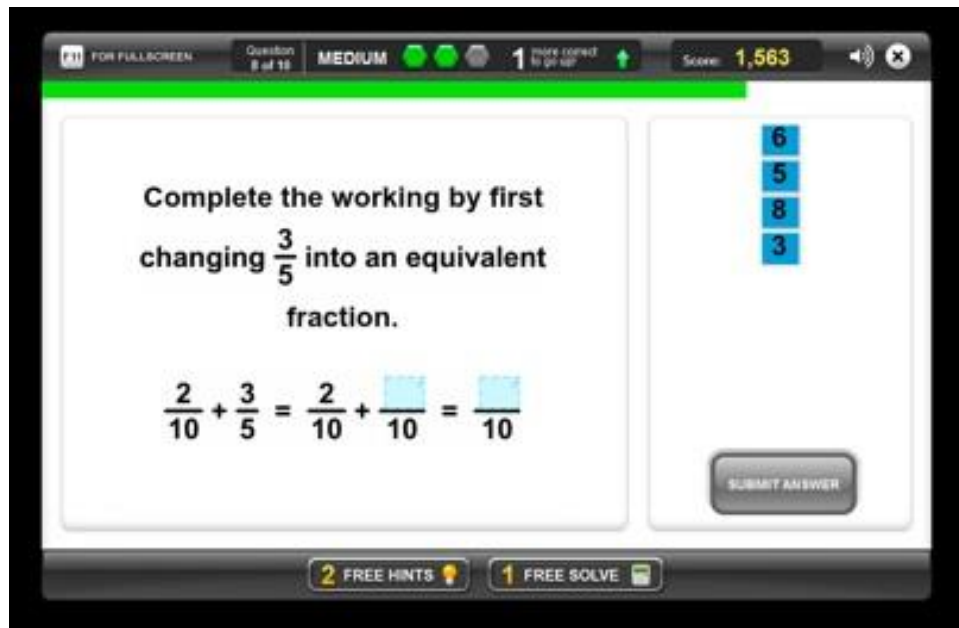


Figure 8: Mangahigh “Medium” question

As a question moves to the next level of difficulty, MagnaHigh points out to the student that he cannot add $\frac{2}{10}$ and $\frac{3}{5}$. It reminds the student to first change $\frac{3}{5}$ into an equivalent fraction and it even shows the student that $\frac{3}{5}$ will change into $\frac{__}{10}$. After correctly answering three “medium” level questions, a student will attempt questions at the “hard” level as seen below.

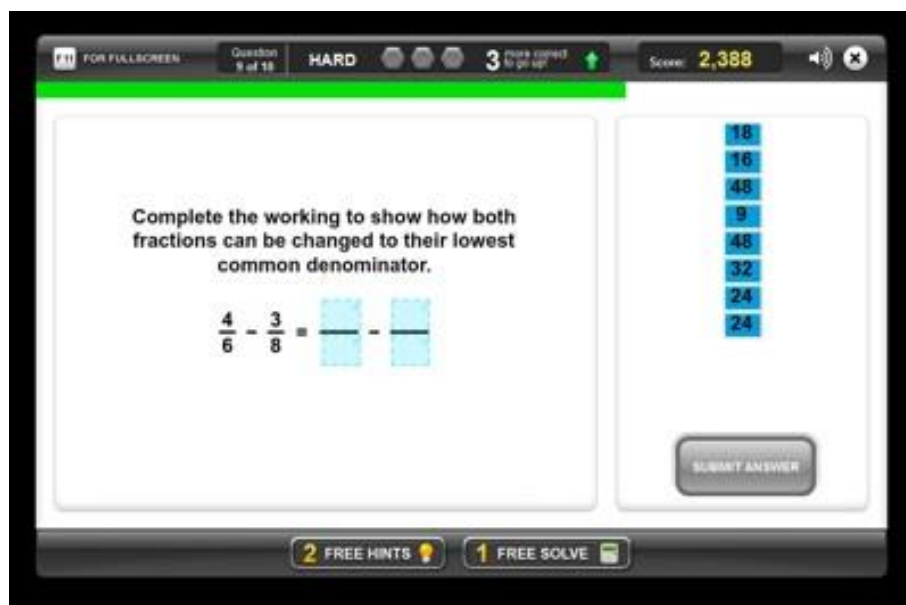


Figure 9: Mangahigh “Hard” question

Students will notice a significant jump in difficulty at this level. Now they must use a method to find the lowest common denominator (also known as least common denominator) in order to correctly set up this problem. The answer choices includes the distractor “48” which is a *common* multiple of 6 and 8, but not the *least* common multiple. Many students may move back down to “medium” level questions and back up to “hard” level questions for a few prodigis. After each prodigi students can review their incorrect choices to see the mistakes they have made and learn from them as they continue the challenge. Advanced students may move on to “extreme” questions and a the screenshot below shows an example of this level.

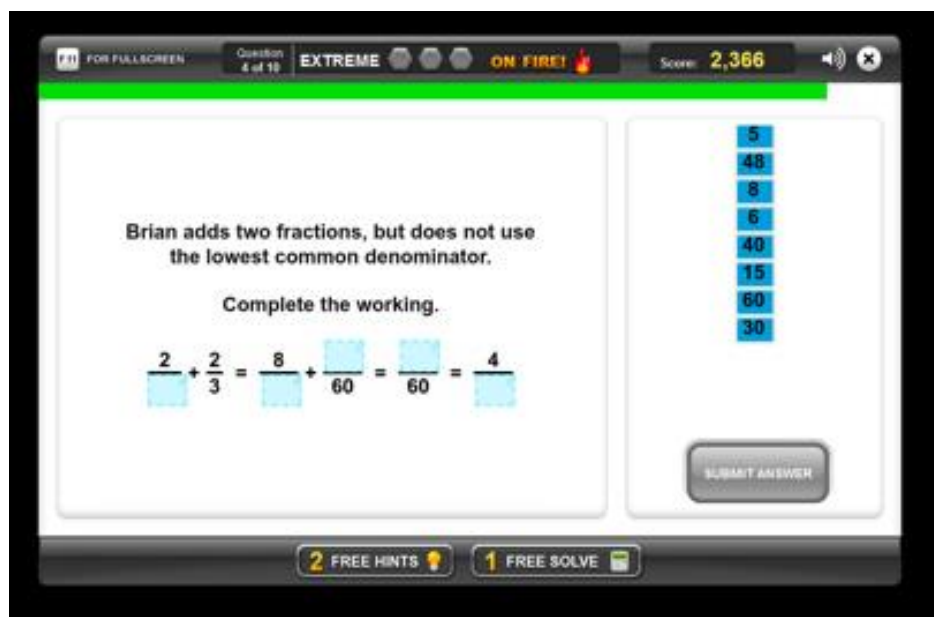


Figure 10: Mangahigh “Extreme” question

This problem can be a little overwhelming at first because the problem points out that Brian does not find the lowest common denominator, a wrinkle in the problem that adds to its difficulty. It is important to remember that not all students will make it to this level of questioning, rather, only the students who are the most advanced in math will reach it and have the opportunity to attempt it.

Mangahigh gives teachers added flexibility when providing instruction to their students. For example, if after a few prodigis, a student is stuck on “easy” level questions and not progressing, the teacher can have the student try another prodigi. The teacher does not need to rummage through a filing cabinet for a worksheet or send a student to the office to make copies of it; instead she can have the student complete the “Equivalent fractions” (which is a third grade skill in CCSS) prodigi as a review. Once the student has mastered that skill, he will be able to attempt the “Adding and Subtracting Equivalent Fractions” prodigi. A progression of the “Equivalent Fraction” podigi questions is shown below.

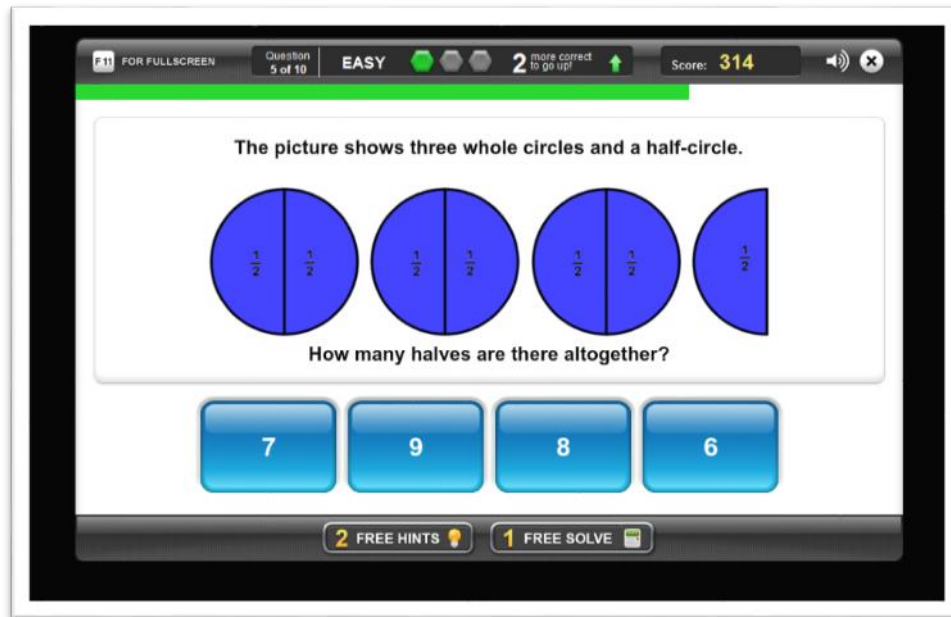


Figure 11: Mangahigh “Easy” question

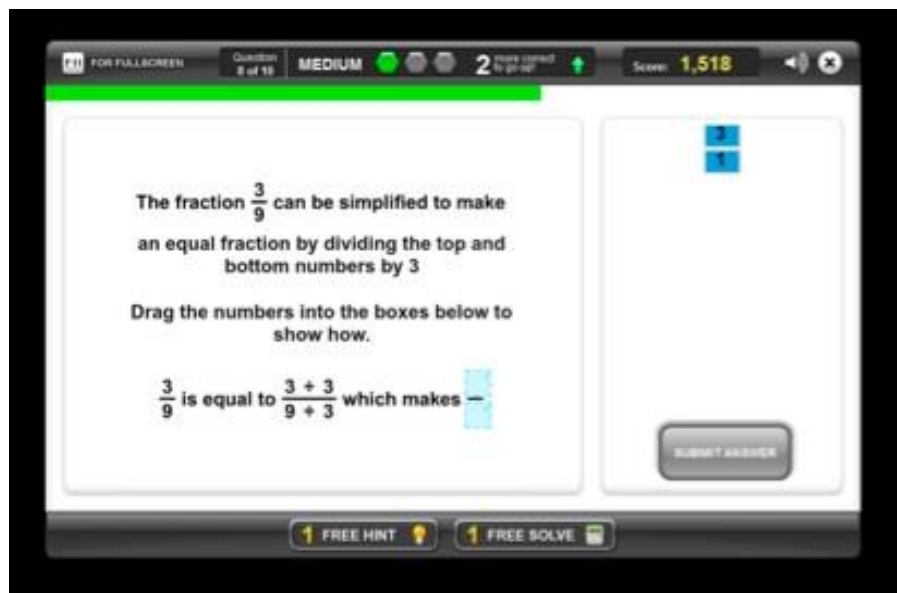


Figure 12: Mangahigh “Medium” question

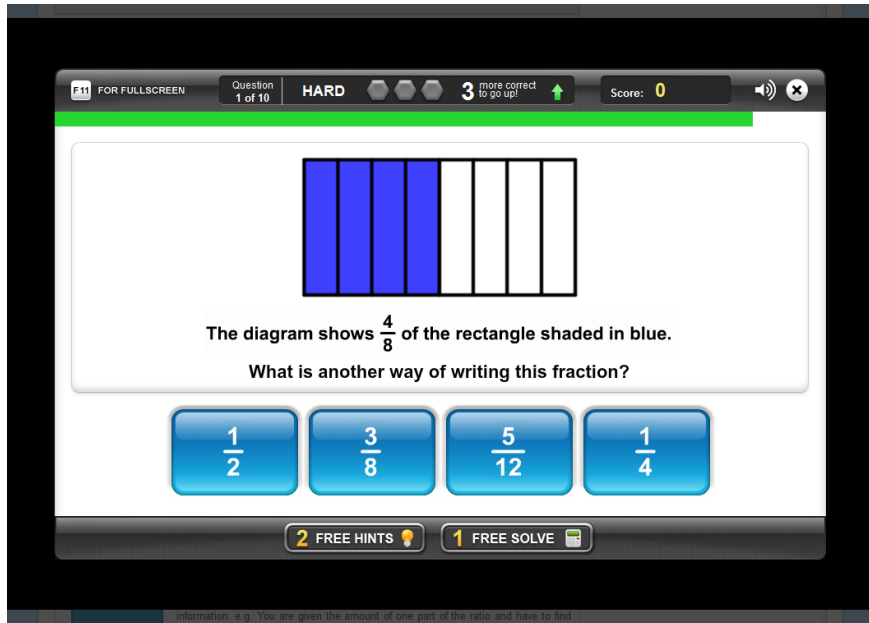


Figure 13: Mangahigh “Hard” question

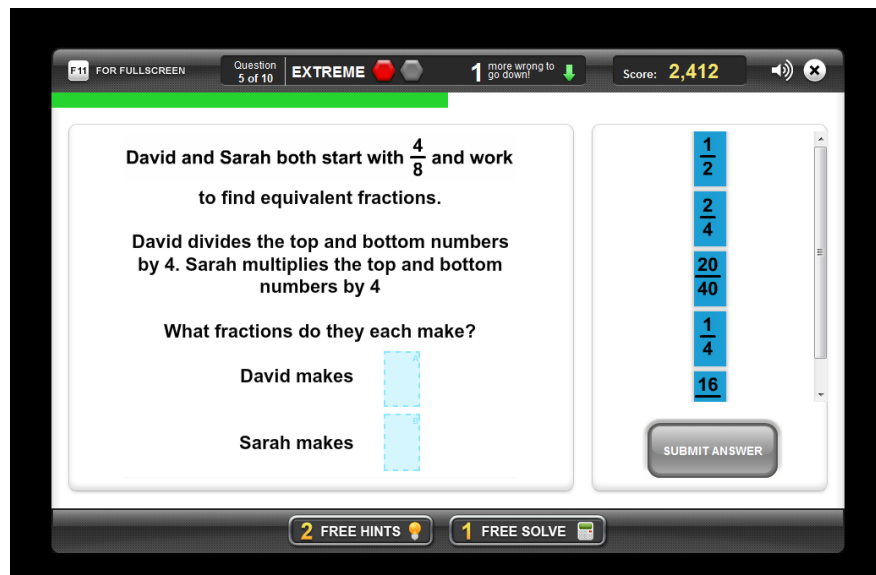


Figure 14: Mangahigh “Extreme” question

Teachers must help students to develop their confidence in order for any “buy in” to occur. This involves two elements: designing tasks in which students can succeed and providing the appropriate scaffolding to help them to learn necessary skills or concepts (Kilpatrick, et al, 2003). Mangahigh allows teachers to provide these two elements and help students to develop self-confidence.

Internet, cellphones, tablets, and cable television have made this the most connected generation in history and eight to 18 year olds have an average of seven hours and 38 minutes of screen time per day. This number does not take into account children who are using more than one device at a time such as surfing the internet on a cellphone while watching TV. When “media multitasking” is added, they average ten hours and 45 minutes per day of screen time (Rideout, Foehr, & Roberts, 2010). While critics may have concerns with these numbers, today’s teachers need to adjust to instructional practices to align with how students use technology as part of their daily lives. That is, students are entering into today’s classrooms *expecting* technology, not just hoping for it because, for most students, it has been a part of their life for as long as they can remember. In fact, one application available in the Apple App Store is “Sparkabilities Babies 1 HD.” This \$5 app allows a parent to hold his infant while the baby shakes an iPad like a rattle. It is marketed for babies who are at least three months old, but simple enough so that older infants can play by themselves (Eaton, 2011). While this is an extreme example, it does demonstrate how different incoming students are with the knowledge and use of technology compared to previous generations and today’s classrooms must find ways to utilize technology or risk losing their students’ interests.

Mangahigh has the potential to support students because it *feels* like a game, but it does not have the aspects of many online games students play. For example, a student does not have a character that moves or shoots, instead the focus is on computation and problem solving. In a recent study, Ke (2008) compared educational games to math drill games found that "...computer math drill games, even though being more simplistic than commercial role-playing games in terms of visual, activity, and interaction design, still significantly enhance students' positive attitudes toward math learning" (p. 1618). He goes on to say, "participants have performed committed and effortful on-task learning when playing certain games where math drills were integral to the gameplay and appropriately challenging" (p. 1618). However, finding math games that fit this description can be a difficult task for teachers because often math games either focus too much on the gaming aspect and not enough on the mathematical task or they lack the ability to differentiate to a student's true ability level.

Students' off-task behavior is a major concern in most classrooms. When students get bored, whether they have a complete understanding of the material or lack any knowledge of the concept, it can lead to the same negative consequences. Students' off-task behaviors not only cause them to miss out on their own learning opportunities, but often negatively affect the learning of those around them as well. While math games are still a new instructional activity and little research has been done on their effectiveness at the elementary level, they may have the potential to engage students in on-task behaviors. For example, Kebritchi, Hirumi, and Bai (2008) studied the effectiveness of math computer games on high school students' math achievement and motivation, and according to the teachers in their study "the games were effective teaching and learning tools because they (a) were experiential in nature, (b) offered an alternative way of teaching and learning, (c) gave the students reasons to learn mathematics to

solve the game problems and progress in the games, (d) addressed students' mathematics phobias and (e) increased time on task. As one of the teachers stated: "It [the games] makes them want to learn [math]" (p. 11-12). Kebritchi and colleagues also found that student assessment scores increased, while simultaneously increasing student learning to the point where many students worked on the math games at home. Like the math games in this study, Mangahigh also has seventeen games available for students to play. These games apply the same computer adaptive technology as the prodigis, but include more of the gameplay aspects students look for when playing video games. Thus, in addition to their assigned task, students can play these games during free choice activity time in the classroom or they can be offered as a resource that students participate in at home.

Computer Adaptive Tests

Since the implementation of NCLB, assessments have played an increasingly important role in schools. The incoming CCSS, while changing the test itself, does not appear to decrease the focus of the assessment. PARCC (2012) quotes Secretary of Education Arne Duncan on their Item Development Proposal, "I am convinced that this new generation of state assessments will be an absolute game- changer in public education."

SBAC is currently working on a CCSS assessment for 25 states and the U.S. Virgin Islands including the Kansas College and Career Ready Standards (KCCRS) and their description sounds similar to the premise of Mangahigh:

The Smarter Balanced assessment system capitalizes on the precision and efficiency of computer adaptive testing (CAT) for both the mandatory summative assessment and the optional interim assessments. Based on student responses, the

computer program adjusts the difficulty of questions throughout the assessment.

For example, a student who answers a question correctly will receive a more challenging item, while an incorrect answer generates an easier question. By adapting to the student as the assessment is taking place, these assessments present an individually tailored set of questions to each student and can quickly identify which skills students have mastered. This approach represents a significant improvement over traditional paper-and-pencil assessments used in many states today (smarterbalance.org, 2013).

The computer adaptive assessment marks a major shift in testing in the United States and many teachers and students will go through growing pains as they learn this new system. For example, Ysseldyke and Bolt (2007) studied the effect of technology-enhanced continuous progress monitoring and its influences on math achievement. Specifically, the study investigated how a computer program could encourage progress monitoring by teachers. Results showed that “students whose teachers use continuous progress monitoring and instructional management systems significantly outperformed those [students] whose teachers solely use the math curricula being used in their district” (Ysseldyke & Bolt, 2007, p. 464) These findings suggest that teachers who use a program like Mangahigh, which includes computer adaptive tests and provides data that will allow teachers to monitor their students’ progress, will be better prepared and perform better on assessments compared to teachers who use traditional instructional practices.

To be proficient in math, *Adding it Up: Helping Children Learn Mathematics*, a report by the National Academy of Sciences, The National Academy of Engineering, The Institute of

Medicine, and National Research Council (2001), states that students need to have knowledge and skills related to the following five strands:

- Conceptual understanding - comprehension of mathematical concepts, operations, and relations
- Procedural fluency - skill in carrying out procedures flexibly, accurately, efficiently, and appropriately
- Strategic competence - ability to formulate, represent, and solve mathematical problems
- Adaptive reasoning - capacity for logical thought, reflection, explanation, and justification
- Productive disposition - habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy

Currently, teachers in the United States do not use instructional strategies that allow students to develop mathematical proficiency (Kilpatrick, 2003). New technologies have the potential to help students develop such proficiency. In fact, the NCTM states that “technology is an essential tool for teaching and learning mathematics effectively; it extends the mathematics that can be taught and enhances students’ learning” (2003). Further, the NCTM states in their executive summary that “technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology. Effective teachers maximize the potential of technology to develop students’ understanding, stimulate their interest, and increase their proficiency in mathematics. When technology is used strategically, it can provide access to mathematics for all students” (NCTM, 2008)

When discussing mathematical proficiency, it is important to keep in mind all five strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick, 2003). However, two of these strands, conceptual understanding and procedural knowledge or “procedural skill,” need to be of primary focus (Rittle-Johnson, Siegler, & Alibali, 2001). That is, “competence in domains such as mathematics rests on children developing and linking knowledge of concepts and procedures...Specifically, we propose that conceptual and procedural knowledge develop interactively, with increase in one type of knowledge leading to increase in the other type of knowledge” (Rittle-Johnson, 2001, p. 346).

Mangahigh also places an importance on strategic competence, which has been defined as the “ability to formulate, represent, and solve mathematical problems” (Kilpatrick, 2003, p. 127). Further, “there are mutually supportive relations between strategic competence and both conceptual understanding and procedural fluency” (Kilpatrick, 2003, p. 127). This renewed focus on strategic competence will require a major change in mathematics instruction. Thus, the CCSS, with an emphasis on strategic competence, may help “to move classroom teaching away from a focus on worksheets, drill-and-memorize activities, and elaborate test-coaching programs, and toward an engaging, challenging curriculum that supports content acquisition through a range of instructional modes and techniques, including many that develop student cognitive strategies.” (Conley, 2011, p. 17) This will involve many new strategies such as an increased focus on problem solving, group work, and open discussions about math concepts. Computer adaptive programs will need to have a focus to achieve the goals of CCSS. The last two strands of mathematical proficiency are adaptive reasoning and productive disposition (Kilpatrick, 2003). These skills are integral to the teaching of math and must be taught to students.

Mangahigh alone cannot create a classroom that has all five of these mathematical proficiencies but it can be a strong tool that teachers use to build a classroom environment where each student is challenged to learn at their own level. If Mangahigh is used properly it can allow a teacher the ability to create lessons where adaptive reasoning and productive disposition can occur.

Summary

Providing differentiated instruction is important for students to learn math concepts. Using technology is one way to help teachers provide differentiated instruction. However, just using technology is not enough, teachers must consider the pro and cons of using technology and choose software or programs carefully. Mangahigh is one website that seems to have the characteristics needed to support student learning and to be engaging to students. Thus, in Chapter 3, I describe how I investigated the potential of Mangahigh to support students' math learning.

CHAPTER 3

METHODS

Introduction

The aim of this study is to determine the effectiveness of the website www.Mangahigh.com when compared to traditional forms of independent practice in a fifth grade classroom. Mangahigh provides an online learning experience where students focus on a particular math skill and computer adaptive technology presents them with the appropriate difficulty of questioning. The second aim of this study is to explore students' attitude towards math and if there are any difference between students who use Mangahigh compared to students in a traditional math class.

Setting

The present study took place at Sandy Hill Middle School (SHMS) a suburban school in the eastern portion of Kansas. SHMS is currently one of two middle schools in the school district and it accommodates 5th-8th grade students. Students at SHMS are classified as 85% European American, 1.7 % African American, 7.9% Hispanic, and 5.4% other; 26.9% of students qualify for free or reduced lunch.

While the 5th and 6th grade students are housed inside the middle school their routines are more similar to an elementary school where they spend the majority of the day in a single classroom learning math, communication arts, and either science or social studies from the same teacher. The students change classrooms three times a day: once for science or social studies as

well as for their two electives. Approximately 190 students are split into seven fifth grade classrooms.

Participants

Teachers. Two teachers participated in this study. I served as one of the teachers; thus, my role is more accurately described a teacher-researcher. I am in my fifth year of teaching 5th grade and all of my teaching experience has been at SHMS. The second teacher is female and she has 21 years of experience. She has taught in multiple school districts and she has taught 3rd, 4th, 5th, and 6th grade. She has taught 5th grade at SHMS for 7 years.

Students. The 5th grade students in our classes were completing their first year at SHMS and most students come from one of three elementary schools in two neighboring towns. All students from our 5th grade classrooms were recruited to participate in the study.

The experimental classroom had 27 total students; however, two students were in the communications program and did not participate in the study due to their modified curriculum. I also had three students in the enrichment program and three students identified as gifted; two of those three had been identified as gifted in mathematics. Consequently the three students identified as gifted completed enrichment work in addition to or instead of Mangahigh to better meet their needs. . Further, because these three students have such strong backgrounds in mathematics and have mastered some of these skills prior to the start of this study, they can be considered outlier. The control or traditional class had 26 students at the beginning of the study and finished with 25 students, as one student moved out of the district during semester break. Although the control class did not have any students in the special education program, they did

have five students who stayed after school one afternoon a week for approximately one hour to receive additional support on skills learned in mathematics that week. Consequently, data was disaggregated so that the students identified as gifted and the students who received extra math support afterschool were removed from the data set so that student who received a similar amount of time in math instruction could be compared .

Procedures

The study took place over approximately eight weeks and both classes at SHMS followed the same long- range calendar for math, which was set by the school district. In addition to the new Kansas College and Career Readiness Standards (KCCRS), the district, and teachers are implementing a new math series: *Math Expressions Common Core* by Houghton Mifflin Harcourt. The textbook is divided into eight units and unit four, Multiplication with Whole Numbers and Decimals, and unit five, Division with Whole Numbers and Decimals, were taught during this study. Each teacher provided daily instruction through explicit instruction, and guided practice then students completed an independent practice activity. Each class also provided one hour and thirty minutes of math instruction per day. Further, both classrooms had access to the same materials and resources other than the implementation of Mangahigh.

Specifically, after explicit instruction, students in the experimental class participated in guided practice. Each student was required to answer 2-3 questions to show they had a basic understanding of the concept before logging into Mangahigh, which used a software program to adapt questions to each student's ability level. That is, Mangahigh differentiated lessons it presented to students based on their prodigi score. The amount of time a student spent on Mangahigh was dependent on his or her ability to attain a basic understanding of that lesson's

skill. However, each student typically spent no less than 30 minute and no more than 45 minutes on the website. On the other hand, students in the control classroom used resources such as worksheets that do not adapt to students' level of understanding. Each student started with the same question and answered problems in order regardless of their ability level. Further, students completed a specific number of questions required of them or the maximum number they could compete during the allotted time.

Data Collected and Analyzed

Students in both classrooms took a pretest consisting of ten questions, which were compiled from assessments created by the textbook, *Expressions*, to avoid teacher-researcher bias. Problems were also taken from the *Getting Ready for PARCC* supplemental material that was published with *Expressions*. I then created the post-test questions by following the format in the pretest, and changing the numerals and labels in questions. See Appendix B for examples of test questions. A t-test was used to analyze the students' assessment scores. Further, data were disaggregated to control for outliers.

Students also completed an interest survey. The *Math and Me Survey* (Adelson & McCoach, 2011) quantifies intermediate students feelings about mathematics (See Appendix C). This survey was completed at the beginning and end of the study. A t-test was used to analyze the students' scores on the survey. These data were not disaggregated due to the anonymity of the survey.

Lastly, students in the experimental classroom completed a five-part questionnaire consisting of open-ended questions on Mangahigh and their math instruction. Students were asked to explain whether they enjoyed the website or not and to give reasons for their opinions.

The questionnaire also asked students about their favorite and least favorite parts of the website. Further, the survey asked them about the frequency in which they used the website and suggestions for how a teacher might improve math instruction. This qualitative data is shared to help frame the quantitative data from the pre- and post-test, and “Math and Me” survey.

CHAPTER 4

RESULTS

Introduction

The aim of this study is to determine the effectiveness of the website www.Mangahigh.com when compared to traditional forms of independent practice in a fifth grade classroom. The second aim of this study is to explore students' attitude towards math and if there is any difference between students who use Mangahigh compared to students in a traditional math class. Thus, qualitative and quantitative data from an approximately eight week study of two fifth grade classrooms at SHMS, one teacher implementing Mangahigh and the other teaching using a traditional approach, are presented. First, the findings of student growth, as measured by pre and post tests for each unit, is presented. Second, the qualitative data collected through the "Math and Me" survey is discussed.

To answer the first research question, what is the effectiveness of the website www.Mangahigh.com compared to traditional forms of independent practice on the learning outcomes of students' in fifth grade classrooms data was collected during two math units; unit four, Multiplication with Whole Numbers and Decimals, and unit five, Division with Whole Numbers and Decimals, were taught during this study.

Unit Four

The first unit under investigation was unit four and students were administered the pretest created with questions from the *Expressions* textbook. This test, which was made up from questions provided by the publisher, was worth twelve points. Ten total questions were asked,

with two questions being worth two points each. These questions included one point for correctly setting up the problem and another point for correct computation. The post-test was created by changing the values and labels for each item, but asking comparable questions. It contained the same number of questions and points.

Students in both the experimental and control classrooms had a mean score of 38% on the chapter four pretest. On the post-test, students in the experimental class had a mean score of 80% and students in the control classroom scored 81% ($t(46) = -0.28, p = .39$). Three gifted students are included in these results. Two of these students had a firm understanding of the material before the pretest and their high marks on this pretest may have skewed the classroom mean since they left little room for personal growth on the post-test. When these students' scores were removed from the data, the experimental group increased 43% and the control grew by 42% ($t(22) = -0.04, p = .48$). Lastly, when the students who received extra support after school from the control classroom were removed along with the gifted students from the control class, both classrooms grew by 43% ($t(37) = -0.02, p = .48$). No significant statistical difference were found from these data when the outliers were removed.

Unit Five

The pretest for unit five was created in a similar manner to unit four and it also contained ten questions. There were five simple computation problems worth one point each and the remaining five questions were valued at three points each: one point apiece for setting up the problem, computation of the problem, and correctly answering the questions with focus on how (if necessary) to use the remainder in the answer (e.g. using decimals with money or rounding up when a fraction will not suffice).

The experimental group scored a class mean of 43% on the pretest and recorded a growth of 44% after achieving 87% on the post-test. The control classroom scored a class mean of 32% on the pretest and attained a 74% on the post-test marking a 42% growth ($t(46) = 0.29$, $p = .38$). These scores once again appear near-identical, however when the numbers are adjusted to remove the gifted students the experimental group grew from 36% to 85% for a 49% improvement ($t(44) = -0.04$, $p = .48$). When the all outliers were removed from the data, the experimental grew by 49% and the control gained 38% ($t(39) = 1.74$, $p = .04$). Thus with all outliers removed there was a statistically significant difference between experimental and control groups' test for unit five. This is potentially due to the fact that the students had consistently used Mangahigh for over two months and their familiarity with the website allowed them to better learn from the online tasks.

Student Survey

To answer the second research question, is there any difference in attitude toward math between students who use Mangahigh compared to students in a traditional math class, students were administered the “Math and Me” survey. The results of the survey, whether the gifted students are part of or removed from the experimental data, are quite similar. Further, the data collected from the “Math and Me” survey provided an interesting perspective. The student survey includes eighteen questions—eight questions measuring the students' self-perception of their math abilities and ten questions quantifying their enjoyment of math.

The experimental group saw a greater increase (or in a few cases a lesser decrease) in seven of the ten “enjoyment” questions. The students using Mangahigh demonstrated a 3% growth in their enjoyment of math, while the students using traditional forms had a 1% loss in

their enjoyment of math. The experimental group also scored higher on seven of the eight questions when students measured their self-perception of math abilities. Thus, the experimental classroom showed an 11% increase in their self-perception of math abilities while conversely the experimental group showed a 4% increase.

Questions on the included items such as, “I can solve difficult math problems” and “I enjoy doing math puzzles” and students in the experimental class demonstrated a 17% and 18% increase in these questions respectively, while showing a 16% increase in disagreeing with the statement “math is hard for me.” On the other hand, student in the control classroom demonstrated a decrease in their responses to the first two statements and an increase in the last statement on the survey.

When the class’ enjoyment and self-perception of math scores were added together the experimental class demonstrated an overall growth of 6%, while students in the control class demonstrated a 1% overall gain. In short, students in the experimental group felt more confident and satisfied with their learning process and in their own abilities at the end of the study compared to students in the control group.

Student Questionnaire

Qualitative data was also collected from students in the experimental group. At the end of the study, students were asked them to candidly respond to five open-ended questions (See Appendix D). Results show that 68% of students said they enjoyed using Mangahigh. For example, Samantha (all names are pseudonyms) said she enjoyed using Mangahigh because “it has helped me through the year with all this new math and it’s like an online tutor.” While

Mackenzie said she enjoyed Mangahigh because “it makes math a lot easier and more fun to learn.”

On the other hand, students who did not enjoy Mangahigh often described not enjoying math—not necessarily Mangahigh. However, a common complaint from those who disliked the website explained, like Taylor, “I don’t enjoy Mangahigh because I don’t like how they time you.” Another common theme by those who do not enjoy the website was explained by Peyton, who wrote, “(Mangahigh) is not very fun for me. It gives hard problems for me.”

Students in the experimental classroom were also asked about the frequency with which they would like to use Mangahigh and 72% of students said they would like to use the website at least the same amount of time or more frequently. Scott indicated that he would like to use Mangahigh more often because “I like the way it helps me learn.” Juan also would like to use the website more frequently so “I can get better and faster at math.” Further, one student who struggles in math, David, says he would like to use it more often “because it helps me with difficult problems.”

Students who wanted to decrease their amount of time on the website often express frustration in completing the prodigi in lieu of the more fun games. As Andrew explained, “I would like to use MangaHigh more for the games and a little for the work.” Kendra shared this sentiment, “Less often, because we never get to do the games.” Thus, the most common theme from students who did not enjoy using the website was the limited time they had to play online games. As the teacher-researcher, I had student focus on the prodigis more than the games because I believed them to be more beneficial to student learning, but it is clear the students had other ideas. That said, some students expressed frustrations with the website beyond their access

to games. For example, Marisa's opinion gives insight on students who prefer a more low-tech approach to mathematics or possibly learning, "...I also get tired of the laptops!"

Finally, when asked, "What advice would you give Mr. Argubright to improve math class?" John said simply and concisely, "Give us less math worksheets."

In short, the primary theme from the student questionnaire was that students viewed the website, Mangahigh, in a positive light. For example, the majority of students indicated that they enjoyed the website and wanted to use it as often or, in most cases, more often. Another theme, though less common, was that students preferred the games on the website rather than the prodigi.

CHAPTER 5

DISCUSSION

The purpose of this study was to examine the effectiveness of math instruction that included an online resource, www.Mangahigh.com, compared to traditional math instruction practices across two math units, as well as to compare students' attitude math. Two important findings are discussed. First, while there were no statistically significant differences when comparing the gains in math for all students between the classes, there was a statistically significant difference between students in the experimental and control class in the second unit once all students who received different or additional math instruction were removed from the data. This seems to suggest that when students used Mangahigh consistently for two months and became more familiar with the website they may be better able to learn from the online tasks. However, further research is needed.

Second, findings from the "Math and Me" survey showed that students in the experimental group felt more confident in their math abilities and enjoyed their math class more at the end of the study compared to students in the control group. This finding was supplement by qualitative data gathered in the experimental class and identified the primary theme that students viewed the website, Mangahigh, in a positive light. These results are significance because, as Anderman and colleagues (2001) argue, "Whether or not students develop a sense of valuing math and reading during the elementary and middle school years can have profound effects on students' future plans and potential career trajectories. Developing a distaste for these subjects during childhood may lead the young adult to rule out mathematics and reading-related career choices" (p. 77). While less common, another theme was that some students preferred the

games on the website rather than the prodigi. Thus, future research might identify the benefits Mangahigh's of game-like online math instruction compared to its prodigi math instruction.

Implications

There is emerging evidence that Mangahigh supports math instruction, particularly related to students' attitude to math; therefore, teachers should feel comfortable using Mangahigh with their students in lieu of or in addition to more traditional forms of independent practice. While additional studies are needed, the present study demonstrates the potential benefits of Mangahigh. Specifically, student "buy-in" remains a primary concern for many teachers and this study demonstrated that students enjoyed using Mangahigh. In addition, most students indicated that they would like to use it as often, if not more often, in class. Further, Mangahigh provides an avenue for teachers to use technology in a manner that students crave in school and teachers can use meaningful, real-time data provided by Mangahigh to make informed instructional decisions.

While Mangahigh is just one of many tools in a teacher's toolbox, it may be an important tool as the CCSS has ushered in an increased focus on problem solving and critical thinking. That is, as teachers provide opportunities for students to look up from their laptops to participate in class discussions, or group work, the Mangahigh might help to provide the foundation for such talk and it has the potential to help students build the foundation for more complex problem-solving based on deep conceptual understanding. This is important because "with a solid base of conceptual knowledge, students can invent their own procedures, resulting in a more flexible application and better transfer to novel problems (Schoppek & Tulis, 2010).

Limitations

As with all studies, there are limitations with the present study. First, the present study was only eight weeks in length and covered only two units. Second, only two classes were involved; therefore, it was difficult to find statistical significance. A longer study investigating more math units and involving more classes may help to provide more conclusive findings.

Further, the tests administered included questions from the accompanying textbook to avoid bias. Although the textbook publisher claimed the questions to be “PARCC ready,” upon closer examination, the questions do not seem to align with the higher-level questions that will be included on PARCC assessment or on the common core-style assessment that the Center for Educational Testing and Evaluation (CETE) is currently creating for the Kansas College and Career Ready Standards. Higher-level questions may have better captured the strengths of Mangahigh and student learning. Thus, future research should include such questions.

Despite these limitation, students who used Mangahigh did have a more positive attitude toward math, and for that reason, teachers should be comfortable using Mangahigh as a resource to help students learn math skills. While Mangahigh alone cannot provide students with the learning opportunities they need to succeed in the “real world” or the CCSS, it does provide differentiated instruction that students need to develop math skills, as well as a deeper understand of math concepts.

REFERENCES

- Adelson, J. L., & McCoach, D. B. (2011). Development and psychometric properties of the Math and Me Survey: Measuring third through sixth graders' attitudes toward mathematics. *Measurement and Evaluation in Counseling and Development*.
- Anderman, E. M., Eccles, J. S., Yoon, K. S., Roeser, R., Wigfield, A., & Blumenfeld, P. (2001). Learning to value mathematics and reading: Relations to mastery and performance-oriented instructional practices. *Contemporary Educational Psychology*, 26, 76–95.
- Anjum,
- Battista, M. (2001). Research and reform in mathematics education. In Loveless, T. (Ed.), *The great curriculum debate how should we teach reading and math?* Washington, D.C.: Brookings Institution Press.
- Eaton, K. (2012, September 5). *For a Baby, Mobile Screens to Shake and Rattle*. *The New York Times*. Retrieved July 5, 2013, from http://www.nytimes.com/2012/09/06/technology/personaltech/sparkabilities-babies-1-hd-talking-tom-cat-and-other-apps-for-babies-app-smart.html?_r=1&
- Ke, F. (2008). A case study of computer gaming for math: Engaged learning from gameplay? *Computers and Education*, 51(4), 1618.
- Kebritchi, M., Hirumi, A., & Bai, H. (2008). The effects of modern math computer games on learners' math achievement and math course motivation in a public high school setting.

- British Journal of Educational Technology*, 11–12. Retrieved from http://www.dynakid.com/download/DimensionM_Research_Brief.pdf
- Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.
- Lepper, M. R., Corpus, J. H., & Iyengar, S. S. (2005). Intrinsic and extrinsic motivational orientations in the Classroom: Age Differences and Academic Correlates. *Journal of Educational Psychology*, 97(2), 192 doi:10.1037/0022-0663.97.2.184
- Mangahigh Teacher Guide. (2011). *A Games-Based Math Teaching Resource*. Retrieved from http://images.mangahigh.com/images_349a104_6/pdf/resources/resources_doc_v3-1.8.pdf
- Means, B., Chen, E., DeBarger, A., & Padilla, C. (2011). *Teachers' ability to use data to inform instruction: Challenges and supports*. Office of Planning, Evaluation and Policy Development, US Department of Education. Retrieved from <http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=ED516494> \n http://www.eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED516494&ERICExtSearch_SearchType_0=no&accno=ED516494
- Means, B., Padilla, C., DeBarger, A., Bakia, M. (2009) *Implementing data informed decision making in schools-teacher access, supports and use*. Office of Planning, Evaluation and Policy Development, US Department of Education. Retrieved from <http://files.eric.ed.gov/fulltext/ED504191.pdf>

National Council of Teachers of Mathematics (2001). Technology in teaching and learning mathematics.

[http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/Technology_\(with%20references%202011\).pdf](http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/Technology_(with%20references%202011).pdf)

National Council of Teachers of Mathematics (2003). The use of technology in the learning and teaching of mathematics.

[http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/Technology_\(with%20references%202011\).pdf](http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/Technology_(with%20references%202011).pdf)

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: CCSSO

Partnership for Assessment of Readiness for College and Careers (2012). *Item development:*

Executive summary. Retrieved from

http://www.parcconline.org/sites/parcc/files/PARCC_Item+Dev_REDACTED_FINAL.pdf

Popham, W. J. (2005). *Classroom assessment: What teachers need to know*. Boston: Allyn and Bacon.

Provasnik, S., Kastberg, D., Ferraro, D., Lemanski, N., Roey, S., and Jenkins, F. (2012).

Highlights from TIMSS 2011: Mathematics and science achievement of U.S. fourth- and eighth-grade students in an international context (NCES 2013-009). Washington, DC:

National Center for Education Statistics, Institute of Education Sciences, U.S.

Department of Education.

Rideout, V., Foehr, U., & Roberts, D. (2010). *Generation M² : Media in the lives of 8-to 18-year-olds*. Henry J. Kaiser Family Foundation. Retrieved from

<http://medcontent.metapress.com/index/A65RM03P4874243N.pdf>

Rittle-Johnson, B. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology* Retrieved from

<http://psycnet.apa.org/journals/edu/93/2/346/>

Schoppek, W., & Tulis, M. (2010). Enhancing arithmetic and word-problem solving skills efficiently by individualized computer-assisted practice. *The Journal of Educational Research*.

Smarter Balanced Assessment Consortium (2013) *Smarter Balanced and teachers: Supporting student achievement through meaningful feedback*. Retrieved June 28, 2013, from

<http://www.smarterbalanced.org/wordpress/wp-content/uploads/2012/02/Smarter-Balanced-Teachers.pdf>

Tate, M. L. (2010). *Worksheets don't grow dendrites: 20 instructional strategies that engage the brain*. Thousand Oaks, Calif.: Corwin Press.

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms (2nd ed.)*. Alexandria, Va.: Association for Supervision and Curriculum Development.

Ysseldyke, J., & Bolt, D. M. (2007). Effect of Technology-Enhanced Continuous Progress Monitoring on Math Achievement. *School Psychology Review*, 36, 453-467.

Unit 5 Pretest	
	Name/Number: Date: Homeroom Teacher:
Solve.	
1.	$14\sqrt{97}$
2.	$31\sqrt{5.89}$
3.	$0.7\sqrt{2.45}$
4.	$53 \div 10^2 =$
5.	$9.48 \div 0.01 =$
6.	Julia has \$5.68. She buys as many bookmarks as she can for 75¢ (\$0.75) each. How many bookmarks does Julia buy?

Unit 5 Posttest

Name/Number:

Date:

Homeroom Teacher:

Solve.

1. $13\sqrt{89}$

2. $42\sqrt{9.66}$

3. $0.8\sqrt{3.36}$

4. $8.5 \div 10^2 =$

5. $61 \div 0.01 =$

6. Alexandra has \$7.72. She buys as many pencils as she can for 80¢ (\$0.80) each. How many pencils does Alexandra buy?

Appendix C: Sample Questions from Math and Me Survey

Sample Enjoyment Questions

“I enjoy studying math.”

“Solving math problems is fun.”

Sample Self-perception Questions

“Math is very hard for me.”

“I am really good at math.”

Appendix D: Control Classroom Mangahigh Questionnaire

Name: _____

Mangahigh Survey

The purpose of this survey is to receive your feedback on math class and using www.mangahigh.com. Please give your honest opinions and be specific with your comments.

1. Do you enjoy using Mangahigh? Why or why not?
2. What is your favorite thing about using Mangahigh? Why?

3. What is your least favorite thing about using Mangahigh? Why?

4. Would you like to use Mangahigh more often, less often, or the same amount? Why?

5. What advice would you give Mr. Argubright to improve math class?

Appendix E: T-Tests

Table 1: Unit Four Results

	Groups						
	Experimental		Control				
	N	Mean	N	Mean	df	T	Sig.
All students	25	4.96	24	5.17	46	-0.28	.38
Gifted students omitted	22	5.14	24	5.17	44	-0.04	.48
Gifted students and students engaged in extended learning time omitted	22	5.14	19	5.16	37	-0.03	.49

Table 2: Unit Five Results

	Groups						
	Experimental		Control				
	N	Mean	N	Mean	df	T	Sig.
All students	25	8.8	24	8.46	46	0.29	.39
Gifted students omitted	22	9.73	24	8.46	43	1.14	.14
Gifted students and students engaged in extended learning time omitted	22	9.73	19	7.68	39	1.74	.04